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PROJECT PLOWSHARE

BLASTING A HARBOR

by Christoph Hohenemser

ONE of the biggest and best-developed parts of the Plowshare program is "Project Chariot," a proposal to make a harbor far up on the Alaskan coast by blasting away the shore with atomic bombs. In this job, as in other Project Plowshare proposals, the AEC will supply the explosives, and will otherwise function in the same role as in weapons research: that is, it will take measures necessary to insure public safety, and will collect and record the results.

The advocates of the Alaskan harbor plan look upon it as an experiment aimed at investigating the problems created by large-scale explosions on land. The first question to ask, then, is why nuclear explosives should be used in earthmoving in place of the chemical explosives that have been used in the past.

Why not use TNT?

Chemical explosives have been in use for a long time. In recent years, mining engineers have devised a variety of techniques to harness TNT for special purposes. Probably the largest chemical explosion to date has been a 9 kiloton TNT shot employed in the U.S.S.R. for earthmoving. It is incidentally interesting that the Russians have undertaken a number of huge earthmoving projects in the past few years, and have used chemical explosives in all of them, despite the availability of quantities of nuclear explosives.

The use of chemical explosives in large earthmoving projects does, however, involve two difficulties. One of these is common to all large explosions – chemical or nuclear – but the other is a problem that the use of nuclear power might solve.

Results not Predictable

The general difficulty in employing explosive force of any kind to dig holes is that the results are not very predictable – or to put it in the language of the experts, no dependable "theory of cratering" has yet been developed. Thus in each job the engineer in charge must figure out as best he can how much explosive to use and how deep to bury it. The hole he gets may be half as big as he intended – or twice as big. The reason for this uncertainty is that different kinds of soil and rock respond differently to the explosive force.

How, then, can the problem of digging a hole of the right size be solved? The competent engineer solves it by a series of small blasts, so that a single error in prediction will not be ruinous. With TNT, it is of course a simple matter to divide a large amount into a series of small charges. But even a "small" atom bomb is the equivalent of a very large quantity of TNT. In this

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What is Plowshare

SCIENTIFIC PROGRESS is a mixed blessing. The power that it places in our hands can be used for destructive purposes in war, or to improve human life in peace. Nuclear energy, which is the greatest advance that science has made in the power available to man, is a dramatic illustration of this fact. Ever since nuclear energy was put to its first practical use – in the explosion of the first atomic bomb – there have been strenuous efforts to beat this most powerful sword into an equally powerful instrument of peaceful construction. The most recent effort is "Project Plowshare," which we discuss in this issue of *Nuclear Information,* and in one to follow.

The U.S. program for development of peaceful applications of nuclear energy began soon after the end of the war. Part of the program has been designed to help other countries acquire the basic equipment and knowledge needed to set up their own atomic research programs. The U.S. now has atomic research agreements with 36 countries, and in 1955 President Eisenhower proposed the worldwide Atoms for Peace program at the U.N. These international efforts seem to have succeeded in separating the creative potential of nuclear energy from its heritage of destruction.

In our own program for developing peaceful uses of nuclear energy in the United States itself, matters have been more complicated. Here, peaceful applications have been developed side by side with continued production of nuclear weapons, and some conflicts between the two aims are hard to avoid.

Project Plowshare, first put forward by the Atomic Energy Commission in 1957, is a series of proposals to investigate the peaceful uses of that part of nuclear science which has heretofore been used only for destruction – the nuclear explosion. It consists of a series of underground nuclear explosions designed to yield scientific data, and to test the feasibility of various practical peaceful projects. However, it is also closely tied to an obvious military question – nuclear bombs – and to a political problem – the detection of underground nuclear tests. The long and difficult negotiations for an agreement to end nuclear tests have thus far foundered on the matter of assuring that such tests cannot be hidden by setting them off in underground cavities. Any proposal to continue underground explosions – for whatever purpose – may be expected to affect military developments and disarmament negotiations.

The degree to which Project Plowshare may affect military and political problems is a matter of opinion. Dr. Edward Teller, a proponent of the project, believes

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respect conventional explosives are superior to nuclear blasts.

The second difficulty in the use of chemical explosives for earthmoving is that the cost is directly proportional to the amount of material moved. It doesn't matter whether you move 10 cubic yards or 10 thousand – it still costs $2 to break up a cubic yard of rock. So the blasting out of very large quantities of earth with chemical explosives becomes staggeringly expensive. With nuclear power, on the other hand, the situation is different.

Atomic Blasts are Cheaper

The relative cheapness of atomic explosives for large earthmoving projects is their chief advantage. A 5 kiloton nuclear blast will remove about 500,000 cubic yards of dirt at a cost of about $1.50 per cubic yard. A 100 kiloton blast will remove 10 million cubic yards at the cost of 12 cents per cubic yard.

These costs, given by the AEC, are for the supply of the explosive device and for the cost of emplacement of the device, as well as for investigations necessary to insure public safety. But the price does not include the cost of special investigations necessary to develop a reasonable degree of predictability, nor does it include the cost of removing shattered rock that may land where it is not expected to go. Despite these undetermined factors, however, it is quite clear that nuclear energy can outcompete TNT if the job requires the use of 10 kilotons or more. A 10 kiloton explosion (which is half the size of the bomb that killed 70,000 people at Hiroshima) can make a crater as wide as the length of two football fields, and deep enough to hide a 20 story building.

But Atomic Explosives bring Problems

Cost is the sole advantage of nuclear over chemical materials for very big jobs. In other respects the nuclear explosives present a lot of new difficulties. Here are some of the most important problems:

•*Atomic explosions are likely to inject radioactive materials into the atmosphere.* Some proposals include plans to avoid this danger, but it is not yet clear that it can be entirely avoided.

•*The groundwater will be contaminated with radioactive materials.* The extent to which such contamination will occur is not yet known, although the problem is now being studied.

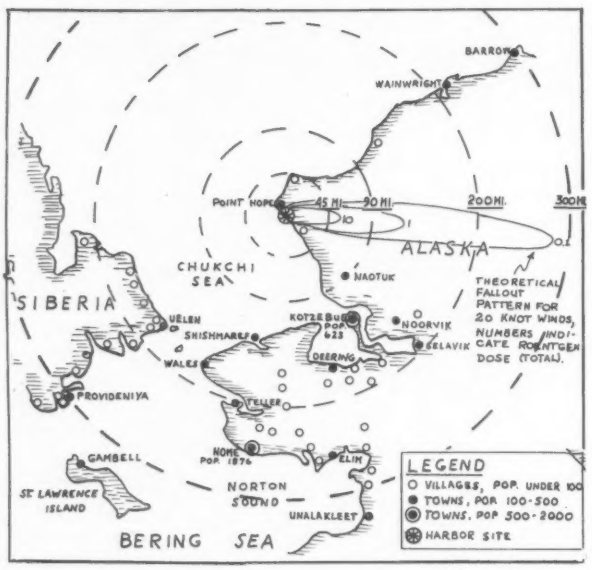
•*Distant objects will be damaged by shock waves.* Such waves travel through the atmosphere or through the ground.

•*The results of a large earthmoving nuclear explosion are now quite unpredictable.* As explained before, engineers are not certain of the effects of even quite small blasts. And there are good reasons for suspecting that the very large blasts, such as will be made with nuclear materials, will have quite different effects from a series of small blasts.

Is it then really feasible to try to dig a big hole by means of an atomic explosion? Probably the best way to deal with this question is to look into Project Chariot, the most fully developed proposal put forward so far.

A Harbor on the Chukchi Sea

Project Chariot is the name applied to the proposed excavation of a small harbor on the Alaskan shoreline 110 miles north of the Arctic Circle. The area is a desolate one, having little commercial, and no industrial activity of any kind. The population is sparse, but the area is nonetheless inhabited. Most atlases show at least two villages near the proposed blast site – Kivalina, quite nearby; and Point Hope, about 30 miles away. Kotzebue, a town of 600 population, is about 120 miles away. The Siberian coast is 160 miles from the site (see map).



The map shows areas of Alaska and Siberia that may be affected by the blasting of the harbor at Cape Thomson. The circles indicate distances from the proposed site; the cigar-shaped pattern suggests possible fallout into the "uninhabited" interior.

According to the plan, the man-made harbor will have an entrance channel about 2000 feet in length and a turning basin 1500 feet in diameter. The AEC proposes to use three 20-kiloton devices, and one 200-kiloton device (of the "all fission" variety) in this job. The purpose of the project, according to the AEC, is experimental – that is, the project is viewed as a means of investigating the problems created by large-scale nuclear explosions. The cost of the harbor is therefore not a matter to be considered, and neither is its apparently negligible usefulness. But there are other serious problems that must be considered.

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The Dangers Involved

Project Chariot poses first of all a dilemma posed by all nuclear explosions: how to achieve a balance between harmful radioactivity and earthmoving effectiveness. If the blasting device is not buried deeply, a large crater will be produced, and the air will be filled with radioactive debris. If the device is buried very deep, the radioactivity released will be negligible, but the crater will be small because it will consist only of the space created by the collapse of the material above the cavity produced by the explosion. The plan in the

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Chariot proposal is therefore to use an explosion that will – if the results agree with the predictions – form a big crater but will reduce the emitted radioactivity to 20 per cent of the total fission yield.

Even this relatively low degree of radioactivity will mean that 10 roentgens of fallout are to be expected 65 miles downwind from the site, and 0.1 roentgen as far as 300 miles downwind. (The maximum permissible daily rate is now set at 0.05 roentgens.) Obviously there will have to be extremely careful monitoring of weather conditions just before the explosion. If the wind is right, the 300 mile zone will extend 140 miles into the Soviet Union. Furthermore, as explained earlier, the unpredictability of cratering may double the planned-for release of radioactivity.

The blast damage has to be considered too. The AEC estimates that to minimize the damage from the air blast, there should be no human habitation downwind for a distance of 385 miles. But as pointed out before, there are small towns – in both Alaska and Siberia – much closer than 385 miles. Apparently a certain amount of window breaking and knocking over of small buildings is to be part of the cost.

And What about the People?

In announcing Project Chariot, the AEC stated, "The Commission does not intend to request the removal of any resident of established communities during this experiment. An experiment would be conducted only after the Commission is assured that public health and safety will be protected."[2]

At first glance, the map suggests that it might be easy to meet the Commission's goal. The only settlements in this area of Alaska are on the coast; the interior is a wild mountainous area, wholly inaccessible except by air. In the proposed Chariot explosion, the intention is to operate under wind conditions that will carry the radioactive fallout in a long cigar-shaped cloud that will extend about 250 miles into the interior of this back-country region. The choice of this direction is explained in a recent Plowshare report which states, "So far as we know, the permanent population in this region is zero although there are trappers and hunters scattered around the interior in the summers."[3]

Of course, the problem is not this simple. Even if no one lives in the area of the blast or in the fallout zone, the residents of nearby communities may be affected if they depend for their livelihoods on animals and plants from the land and sea areas that are affected by the explosion. Accordingly, the AEC has set up an elaborate program to study animal, plant and human life in the western tip of Alaska.

Ecological Studies by the AEC

In the summer of 1959 groups of biologists travelled over the affected land areas, collected animals and plants, and studied their habits. A research ship, the *Brown Bear*, from the oceanographic laboratory of the University of Washington, studied the animal and plant life of the Chukchi Sea – or at least that part of it to the east of the line separating U.S. from Soviet waters.

While no final report of these studies has been made as yet, CNI has had the opportunity to study some preliminary material, and from this, certain basic facts become apparent: 1) oceanographic studies show that there is no possibility of the blast affecting commercial fishing for the simple reason that there are not enough fish to support such activities; 2) very little, if any, plant life is used directly as human food in the area, so that radioactive contamination of plants is only important as it may possibly affect the food supply of animals; 3) birds, which represent important links in the food chain, vary greatly in the amounts of radioactivity that they absorb from fallout now in the area as a result of past nuclear tests.

Most important, of course, is the problem of the human population of the area. Except for government-connected people (civilian and military) and a few guides for big-game hunters, the area has been, and still is, populated chiefly by Eskimo. There are not many of them –fewer than two thousand if we include those at Kotzebue about 120 miles away, and exclude the thousand or so who have aggregated around Point Barrow several hundreds of miles away.

Traditionally, the Eskimo in this area developed two kinds of food patterns: the Coastal Eskimo (chiefly between Point Hope and Point Barrow) depended heavily on whales and other sea mammals and to a lesser extent on fresh water fish; the Inland Eskimo were chiefly dependent on caribou, but also engaged in fresh-water fishing. Both groups hunted birds and land mammals.

At the present time, and for some years now, most of the Inland Eskimo have moved to the coast, and depend, to a greater or lesser extent, on both marine and terrestrial mammals, birds, and fish.[4] With this kind of subsistence pattern, a small group of people requires a relatively large hunting area. The fact that there is no village in the immediate area of the proposed explosion does not mean that people do not use the area and depend on it. There are two small villages north and south of the site of the proposed harbor. Food is so scarce in this region, that the residents of these villages make long trips to hunt and fish over very large areas, which include the region that would be affected by the proposed explosion. When AEC officials visited Point Hope and nearby villages to explain the Chariot plans in the summer of 1959, they found that the members of the Village Council were away on extended hunting and fishing trips.

Biological Data Incomplete

Perhaps the most important conclusion resulting from the 1959 biological studies is was they were too incomplete to determine how the proposed explosion can be carried out within the safety rules set by the AEC. For example, the important oceanographic studies covered only the month of August 1959. Since present recom-

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mendations are that the blast be set off in the spring, these studies needed to be extended considerably before accurate predictions could be made of the effects of the nuclear explosions on ocean life.

As a result of these and similar inadequacies in the ecological information, the AEC Committee on Environmental Studies, on January 7, 1960, included the following paragraph in a two page statement of recommended procedures for the proposed blast:

> The Committee wishes to emphasize the following point: The foregoing discussion and recommendations are based on data presently available. These data are incomplete. Continuing environmental studies are required to satisfy these deficiencies and provide the basis for firm recommendations.[5]

The ecological studies have therefore been continued into 1960 in order to obtain the needed additional information. The matter is of particular interest to the local residents of the area. According to Dr. Margaret Lantis of the U. S. Public Health Service, a leading anthropological specialist in Eskimo studies, Alaska officials, some hunting guides, and the people of the two Eskimo villages closest to the site of the proposed harbor, have expressed concern over the possible effects of the explosion on living conditions.

Thus, while the engineering plans for blasting the Alaska harbor are solved in principle, no one is certain, as yet, that they can be carried out without disrupting the life of the area.

Conclusion

We see that Project Chariot may give new data on cratering for large explosions, and may be experimentally interesting in various other ways. We see also that the safety problems of terrestrial nuclear explosions become severe as the size of the explosion increases. Finally we see that application of large (cheap) earthmoving nuclear explosions in the populated areas (where they are needed) are risky and probably impossible for a long time to come. For even in the remote part of Alaska, where only a few thousand people are affected, the biological difficulties of nuclear blasting are the chief ones.

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that the relationship is slight. At a recent Congressional hearing on the subject, he stated:

> The tools which these experiments [i. e. of Plowshare] develop will differ from nuclear bombs at least as greatly as a passenger car differs from a tank. Certain general principles are similar, but the purposes are different and so are the tools of execution.[1]

On the other hand, Dr. Henry D. Smyth (author of the first public report of the wartime atomic bomb project) testified:

> For fifteen years we have been trying to establish a worldwide system for the control and eventual elimination of nuclear weapons . . . Surely this committee and other committees of the Congress should consider very carefully whether the use of nuclear explosions for peaceful purposes will jeopardize our efforts at international control. Virtuous assurances that such explosions are not being used for weapon development will simply not be believed.[1]

This difficulty is reflected in the recent conflict regarding how much of the technical detail of the first announced U.S. Project Plowshare explosion (scheduled for next January) would be open to international inspection.

All this means that the citizen who wants to evaluate the importance of Project Plowshare needs to find out whether the scientific and technological gains expected from it are enough to outweigh the possibilities of harmful effects on the development of international agreements to stop nuclear tests, and for nuclear disarmament. In *Nuclear Information*, we attempt to evaluate the possible usefulness of some key Plowshare projects: creation of a harbor in Alaska (this issue), and proposals to use nuclear explosions for producing isotopes, for mining, and for power production (the next issue).

C.H., B.C.

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